PATCHES, CLONES AND SELF-FERTILITY OF MAYAPPLES (*PODOPHYLLUM PELTATUM* L.)

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ABSTRACT

Mayapples (*Podophyllum peltatum* L.) grow in patches on the forest floor. Controlled pollinations within and between patches, as well as self-pollinations, indicate that the mayapple is self-sterile in only part of its range, and that in this part of the range, the patches are not single clones, i.e. they consist of more than one genotype.

The mayapple, *Podophyllum peltatum* L., is a common rhizomatous, perennial herb in deciduous forests of eastern North America. It grows in well-defined patches over much of its range, and the form of these patches suggests a clonal development. The patches have been called clones by Rust and Roth (1981), Taylor (1974), and Krochmal, et al. (1974), but those authors did not attempt to investigate the population structure of the patches. Since there is considerable theoretical interest in the structure of populations of asexually reproducing herbs (e.g. Williams, 1975), I wanted to know whether mayapple patches are in general composed of only one genotype, or whether there is more than one genotype per patch.

Mayapples proliferate shoots asexually (Sohn & Policansky, 1977; Holm, 1899), and thus there are fewer genotypes than shoots in a mayapple patch. Given self-sterility, one would expect fewer fertile crosses within patches than between them, because some crosses would be between members of the same genotype. If the patches were single clones then all intra-patch crosses would be sterile. In this paper I report the results of such experimental crosses.

METHODS

I studied mayapples in Bowers Woods, north of Valparaiso, Indiana, in 1976; in the Institute for Advanced Studies, in Princeton, New Jersey, in 1976; in Oak Ridge, Tennessee, in 1975 and 1976; and at the Case Estates of the Arnold Arboretum, Weston, Massachusetts, in 1975 and 1981. At the Case Estates there is one very

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large, poorly-defined patch of probably introduced mayapples. This patch is bisected by a footpath. At the other sites there are numerous well-defined patches of various sizes.

Flower buds were covered with numbered, brown paper bags. At anthesis, pollinations were made between shoots within and between patches, as well as self pollinations. Following the pollinations the bags were replaced. Some flowers were left bagged with no treatment throughout the experiments; others were destaminated, and left bagged. Later in the summer the fruits were examined. At the Case Estates in Massachusetts in 1981 I counted the seeds in each fruit; in the other sites only presence or absence of seeds and fruit size were recorded. There is a good correlation between seed number and fruit size (Sohn & Policansky, 1977).

RESULTS

Some of the experiments in Oak Ridge, and those in Bowers Woods did not yield clear results. Some of the selfed plants produced a few seeds, but most of them and many of the outcrossed plants did not. It appears that self-sterility is not complete at those sites. Clear results were obtained in one Oak Ridge site, in Weston, and Princeton; they are presented for comparison in Table 1.

There was some degree of self-fertility in the populations in Weston and Oak Ridge (Table 1). Additionally, in Weston in 1981, of 12 selfed flowers, 2 produced 1 seed each, and 1 produced 18 seeds. Four outcrossed flowers produced 0, 2, 46, and 53 seeds. Of 99 unbagged flowers, 63 failed to set seed, and of the 36 that did, the number of seeds ranged from 1 to 70, with a mean of 26.3.

Table 1. Proportion of experimental pollinations resulting in production of at least one seed.

LOCALITY AND DATE	SELFED	CROSSED WITHIN PATCH	CROSSED BETWEEN PATCHES
Oak Ridge, 1975	4/6	7/10	—
Weston, 1975	3/23	8/10	—
Weston, 1981	3/12	3/4	—
Princeton, 1975	0/46	8/27	12/12

In Princeton three clearly defined patches showed complete self-sterility. Of 13, 15, and 18 flowers selfed in the three patches none set any seeds, while 2 out of 6, 1 out of 11 and 5 out of 10 flowers outcrossed within the patches set seeds. The difference in proportion of flowers setting seed between selfed and outcrossed flowers is significant by chi-square test at the .01 level. Four flowers from each patch were cross-pollinated with 4 flowers from adjacent paches; all of these set seed.

None of the destaminated flowers or those that were bagged without pollination set any seeds at any of the sites. The proportion of flowers setting seed in untreated populations ranged from zero in a central Tennessee population in 1975 to around 80% in Princeton in 1975 and 1976.

DISCUSSION

The analysis of patches in Princeton demonstrates that they are not single clones. Although self-pollinations never resulted in seeds, pollinations within patches sometimes did, and pollinations between patches always did (Table 1). It is impossible to say how many genotypes there were in each of the three patches. There may have been only two, but there were definitely more than one.

There appears to be considerable variability in the degree of self-fertility over the range of mayapples. The results of this study indicate that the mayapple is not completely self-sterile over all of its range, but that it is in Princeton. Recently Swanson and Sohmer (1976) made some inter- and intrapopulation crosses of mayapples in Wisconsin, to test the hypothesis that interpopulation crosses would be more fertile than intrapopulation crosses. This hypothesis was confirmed. They did not report the results of any self-pollinations, but the low fertility of their intrapopulation crosses in Wisconsin suggests that the plants are probably self-sterile there also.

Williams (1975) presented a model for the evolution of sex in asexually reproducing plants, such as the strawberry. He assumed that single clones formed patches of shoots that were better adapted to their own local environment, due to natural selection, than other clones in the general area. Mayapples grow very much like strawberries, and thus Williams' model applies to them also. The demonstration that at least some of the patches have more than one genotype means that one of the assumptions of the model may not be generally applicable.

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LITERATURE CITED

HOLM, T. 1899. *Podophyllum peltatum*, a morphological study. Bot. Gaz. Chicago **27:** 419–433.

KROCHMAL, A., L. WILKINS, D. VAN LEAR, & M. CHIEN. 1974. Mayapple. U.S. Forest Serv. Res. Pap. **NE-296**. 9 pp.

RUST, R. W., & R. R. ROTH. 1981. Seed production and seedling establishment in the mayapple, *Podophyllum peltatum* L. Amer. Midl. Nat. **105:** 51–60.

SOHN, J. J., & D. POLICANSKY. 1977. The costs of reproduction in the mayapple *Podophyllum peltatum* (Berberidaceae). Ecology **58:** 1366–1374.

SWANSON, S., & S. H. SOHMER. 1976. Reproductive biology of *Podophyllum peltatum* (Berberidaceae): the comparative fertility of inter- and intrapopulational crosses. Wisc. Acad. Sci., Arts & Lett. **64:** 109–114.

TAYLOR, F. G. 1974. Phenodynamics of production in a mesic deciduous forest, p. 237–254 *In:* H. Lieth (ed.) Phenology and seasonality modeling. Springer, NY.

WILLIAMS, G. C. 1975. Sex and evolution. Princeton University Press, Princeton, NJ.

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